THE ARTHROPODA OF WET TREE HOLES

BY

WILLIS EVERETT SNOW

A.B., Univessity of Illinois, 1942
M.S., University of Illinois, 1944

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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THE ARTHROPODA OF WET TREE HOLES

As considered in this thesis, the wet tree hole is a cavity which has been formed in the wood or xylem of a tree, or at least within the vascular tissue, and which can maintain open water for at least four to six weeks during the rainy season. Included as such are collections of water in cavities within the roots and stems of trees, in the rotted interior of stumps, and in the internodes of bamboo. These cavities are formed either as natural hollow partitions of the stem as in bamboo, or by rotting of the solid stem of a tree through the agency of bacteria and the higher fungi. In the United States, I have collected insects from cavities of elm, maple, oak, sycamore, buckeye, sugarberry, hickory, pawpaw, camphor, gum, willow and pine.

The collections of water in wet tree holes have a characteristic straw- or coffee-colored water due to the presence of tannins which have dissolved from the surrounding woody tissues and decaying leaves. Plant and animal matter are constantly being added to the medium and undergoing decomposition by bacteria. It is believed that many insects are attracted to this medium by the highly concentrated organic matter present, especially organic nitrogen. Adult insects, such as mosquitoes, may sense, through their olfactory or other organs, the suitability of the medium by detecting one of the gaseous products of the decomposition, such as methane, as it is liberated from the surface of the water. My observations indicate that methane comprises about 30 percent of the gas evolved in the process of decomposition in tree holes. Very small amounts of dissolved oxygen have been detected,

but this paucity of oxygen appears to have no deleterious effect on the numerous larvae present. Mayer (1938) recorded a maximum of 1.95 ppm. in August for collections of water in beech trees. The temperature of the water in tree holes remains relatively constant throughout the day, and shows a considerable lag seasonally when compared to outside temperature. In Germany, von Brandt (1934) found water in tree holes to vary only 1° C. in a 24 hour period during September and October. These temperature changes depend on the thickness of the tree hole wall, the degree of shade, the size of the orifice and the degree of wind action.

I have discovered tree holes in three phases of development, the phases depending upon the length of time which open water may persist in them, as follows: (1) youthful, with open water remaining less than 6 weeks; (2) mature, with open water persisting more than 4 months; and (3) decadent, wherein water becomes isolated in small areas within the accumulated frass.

The ability of tree hole insects to maintain themselves in youthful, mature, or decadent tree holes is largely dependent upon the length of the insect's life cycle, and type and amount of food available in the habitat or required by the insect.

The following tabulation indicates the genera of insects known in the world from wet tree holes. The asterisk is used to designate regions where I collected individuals of the respective genera. The total number of individuals which I collected, representing the species of these genera, is also given.

Order-Family	Genus	Number of Species	Number of Individuals	Known Occurrence
Collembola				
Poduridae	*Xenylla*	1	100	United States*
	Pseudachorutes	1	3	Guatemala*
Sminthuridae	*Sminthurinus*	3	30	United States*
	Dicyrtomina	1	1	United States*
Odonata				
Agrionidae	*Megaloprepus*	1	3	Guatemala*
Coleoptera				
Dytiscidae	*Copelatus*	1	1	Guatemala*
Dytiscidae	*Laccophilus*	1	1	Guatemala*
Staphylinidae	*Coproporus*	1	1	Guatemala*
	Trachysectus	1	2	United States*
	Genus undet.	1	1	United States*
Pselaphidae	*Hamotus*	1	1	Guatemala*
Helophoridae	*Helophorus*	1		Croatia
Hydrophilidae	*Enochrus*	1	1	Guatemala*
Cyphonidae	*Cyphon*	1		United States
	Helodes	3	94	United States*, Australia

Order-Family	Genus	Number of Species	Number of Individuals	Known Occurrence
Coleoptera (cont'd.)				
	Prionocyphon	17	96	United States*, Guatemala*, South America, Europe, Japan, Australia
	Scirtes	1	1	Guatemala*
Diptera				
Tipulidae	*Ctenophora*	1		Croatia
	Limnonia	1	30	United States*
	Rhiphidia	1		England
	Sigmatomera	3	3	Paraguay, Brasil, Guatemala*
Sylvicolidae	*Mycetobia*	3	25	United States*, England, Costa Rica
	Sylvicola	2	10	United States*, England
Tendipedidae	*Metriocnemus*	2		Europe
	Orthocladius	1	20	Guatemala*
	Tendipes	2	3	Guatemala*, Europe

Heleidae	*Bezzia*	1	200	Guatemala*
	Culicoides	20	525	United States*, Brasil, England, Africa, India, Malaya
	Dasyhelea	9	60	United States*, Germany, Africa, Sumatra
	Forcipomyia	5	10	United States*, England, Brasil, Africa
	Lasiohelea	1		Africa
	Palpomyia	1		Brasil
	Thysanognathus	1		Africa
Psychodidae	*Brunnetia*	1	60	United States*
	Pericoma	3	225	Guatemala*, Germany
	Telmatoscopus	4	150	United States*, Guatemala
Culicidae	*Aedes*	158	2429	United States*, Guatemala*, Cosmopolitan
	Anopheles	18	116	United States*, Cosmopolitan

Order-Family	Genus	Number of Species	Number of Individuals	Known Occurrence
Diptera (Cont'd)				
Culicidae (Cont'd.)	*Armigeres*	10		Austro-Malayan Region
	Corethrella	5	4	Guatemala*, Central and South America
	Culex	35	11	Guatemala*, Cosmopolitan except North America and Europe
	Culiseta	1		Africa
	Eretmapodites	3		Africa
	Ficalbia	1		Malaya
	Haemagogus	10	3	Guatemala*, Central and South America
	Heizmannia	4		Oriental Region
	Limatus	4		Central and South America

Orthopodomyia	18	421	United States*, Cosmopolitan except Canada, Africa, and Russia
Sabethes	8		Central and South America
Topomyia	2		Malaya
Toxorhynchites	21	50	United States*, Guatemala*, Cosmopolitan, except Canada, W. Europe and Siberia
Trichoprosopon	9	330	Guatemala*, Central and South America
Tripteroides	9		Austro-Malayan Region
Uranotaenia	8		Africa, Austro-Malaya, Japan
Wyeomyia	13	3	Guatemala*, Central and South America

Order-Family	Genus	Number of Species	Number of Individuals	Known Occurrence
Diptera (Cont'd.)				
Fungivoridae	*Leia*	1	8	United States*
	Lycoria	1	200	United States*
	Eulalia	1		Croatia
	Pachygaster	1	20	United States*
	Genus undet.	1	12	United States*
Dolichopodidae	*Chrysotus*	3	4	United States*
	Gymnopternus	1	2	United States*
	Hercostonus	1	3	United States*
	Medeterus	1	2	United States*
	Pelastoneurus	1	1	Guatemala*
	Syntormon	1	1	United States*
	Systenus	2		England
Syrphidae	*Cerioides*	1		Brasil
	Helophilus	2		England, Croatia
	Mallota	4	20	United States*, Guatemala*

	Myiatropa	1		Europe
	Myiolepta	2	20	United States*, Europe
	Nausigaster	1		Brasil
	Pocota	1		Europe
	Quichuana	2		Brasil
	Xylota	3	2	United States*
Drosophilidae	*Drosophila*	4	55	United States*
Chloropidae	*Oscinis*	1		Croatia
Ephydridae	*Ephydra*	1	20	Guatemala*
Anthomyiidae	*Dendrophaonia*	1	2	United States*
	Phaonia	4		Europe
Hymenoptera				
Ichneumonidae	*Acanthocryptus*	1		Croatia
Diapriidae	*Loxotropa*	1	1	United States*
Encyrtidae	*Bothriothorax*	1	1	United States*
Formicidae	*Aphaenogaster*	1	6	United States*
	Crematogaster	1	8	United States*

SUMMARY OF MY COLLECTION FROM WET TREE HOLES

Order	Families	Genera	Species	Individuals Collected
Collembola	2	4	6	136
Odonata	1	1	1	3
Coleoptera	5	11	15	199
Diptera	14	38	60	5060
Hymenoptera	3	4	4	16
Total	25	58	86	5414

SUMMARY OF THE KNOWN REPRESENTATIVES FROM WET TREE HOLES

Order	Families	Genera	Species
Collembola	2	4	6
Odonata	1	1	1
Coleoptera	6	12	30
Diptera	14	64	441
Hymenoptera	4	5	5
Total	27	86	483

The individuals, whether eggs, nymphs, larvae, pupae or adults, living in the wet tree hole, may be conveniently separated into four societies on the basis of their relation to the water: wall forms, surfacial forms, sub-surfacial or aquatic forms, and sub-surfacial bottom forms.

The wall forms require moist situations but are not fitted for an aquatic life. Species of Collembola, Cyphonidae, and all the Diptera except several genera of mosquitoes oviposit on the wall. The nymphs of *Xenylla,* and the larvae of *Limnonia, Mycetobia, Sylvicola, Dasyhelea, Forcipomyia, Telmatoscopus, Hercostomus, Drosophila,* and *Dendrophaonia* live in the pulpy matter of the wall. Besides the preceding larvae which pupate on the wall, individuals of the following

genera come from the water to pupate: *Cyphon, Helodes, Prionocyphon, Myolepta, Mallota,* and *Xylota.* The adults of all species frequently rest on the wall, and I have observed those of *Prionocyphon* to mate there. The larvae of *Dendrophaonia* are predaceous. The rest are herbivorous.

The surfacial forms of the wet tree hole do not have the structural modifications of aquatic insects, such as occur in the order Hemiptera, and are very small in size, hence must therefore weigh very little in order to resist wetting. Collembolans of the genera *Pseudachorutes, Sminthurinus,* and *Dicyrtomina* are regular inhabitants of this layer. I observed females of several genera of mosquitoes, *Anopheles* and *Trichoprosopon* to oviposit on the surface, while Paine (1934) watched a female *Toxorhynchites* as she deposited eggs while hovering several inches above the surface of the water.

The principal inhabitants of the aquatic society are larvae and pupae of the following: Cyphonidae, *Cyphon, Helodes, Prionocyphon*: Heleidae, *Culicoides, Bezzia*: Psychodidae, *Brunnetia, Telmatoscopus, Pericoma*: Culicidae, all genera: Sylvicolidae, *Mycetobia;* and Dolichopodidae, *Medeterus, Chrysotus.* The larvae of Syrphidae in the genera *Mallota, Myiolepta,* and *Xylota* move up on the wall of the tree hole to pupate. The rat-tailed larvae of the genus *Mallota* possess a highly modified posterior respiratory apparatus which when fully extended is about 70-80 mm. in length and enables them to feed at the bottom while still maintaining contact with the surface for air. Larvae of *Culicoides, Bezzia, Anopheles, Corethrella, Toxorhynchites, Culex (Lutzia), Medeterus, Chrysotus Systenus* and *Phaonia* are carnivorous. The rest are herbiverous. Incidental forms in this society include naiads of *Megaloprepus,* and coleopterous adults in the dytiscid genera *Copelatus* and *Laccophilus* and the hydrophilid genus *Enochrus.*

The ooze layer on the bottom of the tree hole is frequently visited by members of the aquatic society in search of food,

chiefly larvae of Cyphonidae, Heleidae and Syrphidae. The principal inhabitants of this layer are some very large predaceous larvae of the tipulid genus *Sigmatomera*. They trap mosquito larvae by secreting a substance to which the culicids are strongly attracted. A large number of annelids in the family Enchytraeidae reside in the organic ooze on the bottom and reduce the organic matter to very fine particles, thus preparing it for use by herbivorous larvae. Keilin (1927) found endoparasitic fungi and protozeans in the following genera of dipterous larvae: *Dasyhelea, Rhiphidia, Mycetobia, Aedes* and *Systenus*. Muspratt (1947) discovered a mermithid nematode, *Agamomermis* in naturally infected larvae of *Aedes* and *Culex* in tree holes in Rhodesia. I noted several ectoparasitic fungi on insects in tree holes; *Saprolegnia* on pupae of *Culicoides*, and *Laboulbenia* on the antennae of a Guatemalan collembolan.

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VITA

I was born in Chicago, Illinois on December 8, 1918. I attended the Oak Park elementary schools, and the Oak Park High School, graduating in June, 1937. During the years 1937-1939 and 1940-1942, I attended the University of Illinois, and received the degree of Bachelor of Arts in June, 1942. During the summers of 1943-1945, I was employed as entomologist with the U. S. Public Health Service, and was stationed at Scott Field and Herrin, Illinois. My work for the degree of Master of Science at the University of Illinois was completed in February, 1944. Part of the summer of 1947 was spent in Guatemala collecting material for my doctorate dissertation.

In 1943, I was appointed to the position of teaching assistant in the Department of Botany at the University of Illinois and served in this capacity at least one semester each year until June 1948. In July 1948, I was engaged as biologist in the Department of Health and Safety, Tennessee Valley Authority, and have since

been stationed at Wilson Dam, Alabama.

I am a member of the Entomological Society of America, the American Mosquito Control Association and the American Society of Limnology and Oceanography. While at the University of Illinois, I became affiliated with the Rho chapter of Phi Sigma, and the Illinois chapter of Sigma Xi. I have also served as an exectutive officer in the architectural fraternity Alpha Rho Chi, the National Service Fraternity, Alpha Phi Omega, and from 1944-1947 headed the Guide and Travel Committee of the Illini Union at the University of Illinois.

My publications are: Laboratory Rearing of Culicidae. Trans. Ill. Sta. Acad. Sci. 1943; The Occurrence of *Pictinus aurivillii* Berg. (Dysodiidae Hemiptera) in Illinois. Trans. Ill. Sta. Acad. Sci. 1944; (with W. F. Rapp Jr.) Catalog of the Lonchopteridae of the World. Bull. Brooklyn Ent. Soc. 40:81-83, 1945; Catalog of the Pantophthalmidae of the World. Rev. Entomol. R. d. Janerio. 16:252-254, 1945 and Catalog of the Apioceridae. Pan-Pacific Ent. 21:157-160, 1945.